Skywatchers
Newsletter of the China Lake Astronomical Society

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April 5, 2021 CLAS Meeting

Keith Weisz our Vice President and Program Chair will discuss the Vera C. Rubin Observatory project that will conduct a 10-year Legacy Survey of Space and Time (LSST). LSST will deliver a 500 petabyte set of images and data products that will address some of the most pressing questions about the structure and evolution of the universe and the objects in it. Keith will go over the goals and the design of the telescope.

The May meeting The May meeting will feature Cerro Coso College Professor Scott Cameron discussion on

President's Message

I hope that we will soon be able to meet in person again. The situation in Kern County has improved, and we expect Maturango Museum to be able to open soon. There's a good chance that our May CLAS meeting will be in person, but with attendance limited to twenty-five people—we will also broadcast the May meeting over Zoom if you're not yet able to attend. We will keep you informed.

Meanwhile, we will see you on Zoom on Monday, April 5. To find out how to join a Zoom meeting, go to https://www.chinalakeastro.org/zoom/. Once we resume in-person meetings, would you like us to continue to stream meetings over Zoom, in case you'd still like to attend from the comfort of home? Let us know.

I hope you are all staying well during this pandemic, and have gotten your vaccine—or will soon. (I've received two shots of Moderna with essentially zero reaction.) Have you had a chance to view the night sky lately, especially now that it's warming up? We are planning an Public Observing Night at Maturango later this month, and we'll once again have cameras connected to our telescopes to display images on computer monitors for easier viewing. We'll send out an email when the date is set.

In the meantime, please share any recent observations and sightings with us at the Monday meeting.

Ralph Paonessa-- President, CLAS

Upcoming May Meeting will feature Professor Scott Cameron of Cerro Coso College (Topic to be announced)

China Lake Astronomical Society is inviting you to a scheduled Zoom meeting.
Time: April 05, 2021 07:30 PM Pacific Time (US and Canada)
Join Zoom Meeting
https://us02web.zoom.us/j/6727499334?pwd=VWhuVGZ3aFphL283THRKNUNoZ0RSZz09
Meeting ID: 672 749 9334
Passcode: 9V8FQM
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Dial by your location
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+1 669 900 6833 US (San Jose)
+1 253 215 8782 US (Tacoma)
+1 346 248 7799 US (Houston)
+1 301 715 8592 US (Germantown)
+1 312 626 6799 US (Chicago)
+1 646 876 9923 US (New York)
Meeting ID: 672 749 9334
Passcode: 562029

New Study Sows Doubt about the Composition of 70 Percent of Our Universe.

March 31, 2021
University of Copenhagen - Faculty of Science
Researchers the world over have long believed that 70 percent of the universe is composed of dark energy, a substance that makes it possible for the universe to expand at an ever-increasing rate. But in a new study, researchers tested a model which suggests that the universe's expansion is due to a dark substance with a kind of magnetic force.

Until now, researchers have believed that dark energy accounted for nearly 70 percent of the ever-accelerating, expanding universe.

For many years, this mechanism has been associated with the so-called cosmological constant, developed by Einstein in 1917, that refers to an unknown repellent cosmic power.

But because the cosmological constant -- known as dark energy -- cannot be measured directly, numerous researchers, including Einstein, have doubted its existence -- without being able to suggest a viable alternative.

Until now. In a new study by researchers at the University of Copenhagen, a model was tested that replaces dark energy with a dark matter in the form of magnetic forces.

"If what we discovered is accurate, it would upend our belief that what we thought made up 70 percent of the universe does not actually exist. We have removed dark energy from the equation and added in a few more properties for dark matter. This appears to have the same effect upon the universe's expansion as dark energy," explains Steen Harle Hansen, an associate professor at the Niels Bohr Institute's DARK Cosmology Centre.

The universe expands no differently without dark energy

The usual understanding of how the universe's energy is distributed is that it consists of five percent normal matter, 25 percent dark matter and 70 percent dark energy.

In the UCPH researchers' new model, the 25 percent share of dark matter is accorded special qualities that make the 70 percent of dark energy redundant.

"We don't know much about dark matter other than that it is a heavy and slow particle. But then we wondered -- what if dark matter had some quality that was analogous to magnetism in it? We know that as normal particles move around, they create magnetism. And, magnets attract or repel other magnets -- so what if that's what's going on in the universe? That this constant expansion of dark matter is occurring thanks to some sort of magnetic force?" asks Steen Hansen.

Computer model tests dark matter with a type of magnetic energy

Hansen's question served as the foundation for the new computer model, where researchers included everything that they know about the universe -- including gravity, the speed of the universe's expansion and X, the unknown force that expands the universe.

"We developed a model that worked from the assumption that dark matter particles have a type of magnetic force and investigated what effect this force would have on the universe. It turns out that it would have exactly the same effect on the speed of the university's expansion as we know from dark energy," explains Steen Hansen.

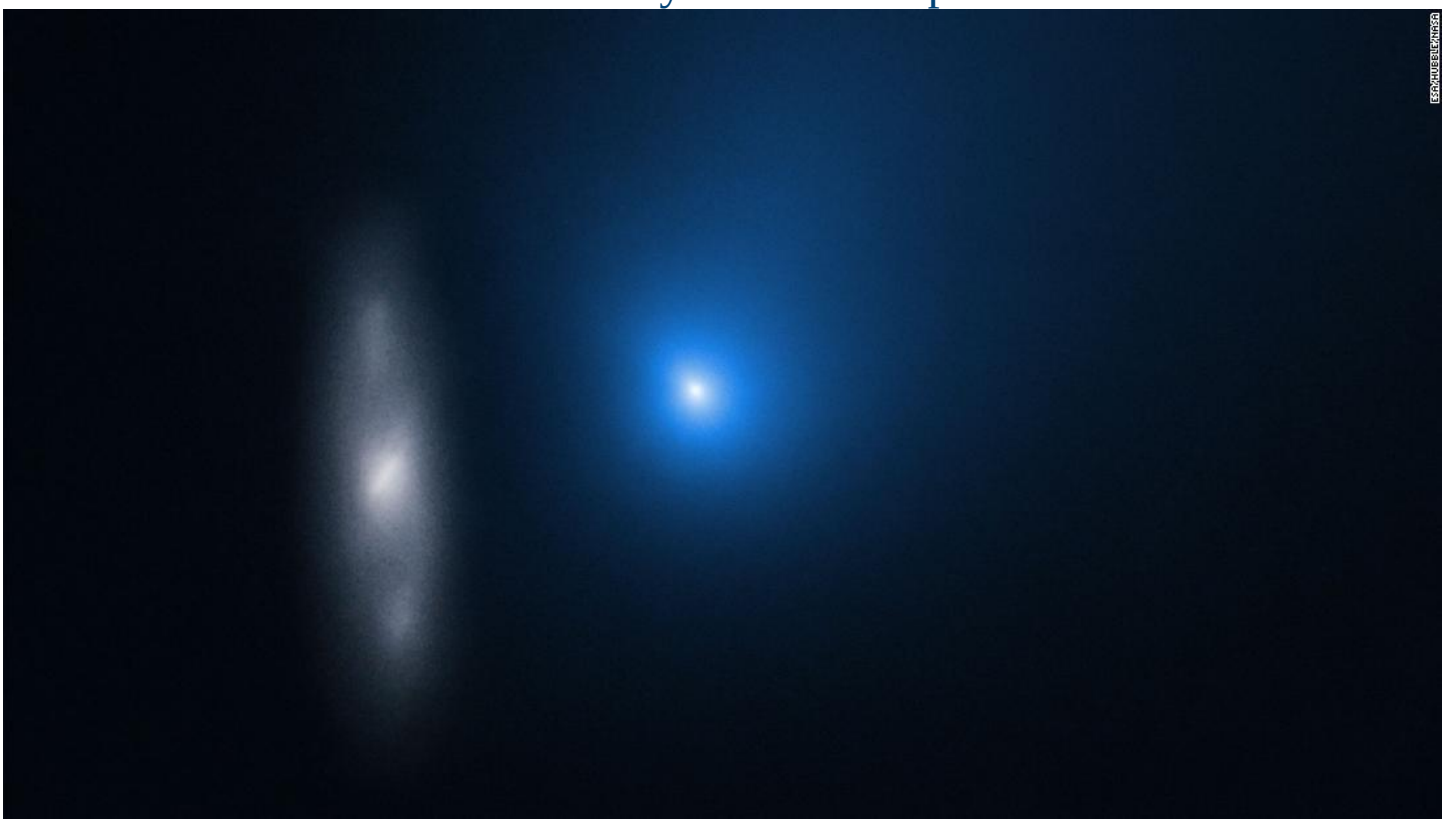
However, there remains much about this mechanism that has yet to be understood by the researchers.

And it all needs to be checked in better models that take more factors into consideration. As Hansen puts it:

"Honestly, our discovery may just be a coincidence. But if it isn't, it is truly incredible. It would change our understanding of the universe's composition and why it is expanding. As far as our current knowledge, our ideas about dark matter with a type of magnetic force and the idea about dark energy are equally wild. Only more detailed observations will determine which of these models is the more realistic. So, it will be incredibly exciting to retest our result.

Source: New study sows doubt about the composition of 70 percent of our universe -- ScienceDaily

First interstellar comet may be the most pristine ever found



2I/Borisov

March 30, 2021
ESO
New observations indicate that the rogue comet 2I/Borisov, which is only the second and most recently detected interstellar visitor to our Solar System, is one of the most pristine ever observed. Astronomers suspect that the comet most likely never passed close to a star, making it an undisturbed relic of the cloud of gas and dust it formed from.

New observations with the European Southern Observatory's Very Large Telescope (ESO's VLT) indicate that the rogue comet 2I/Borisov, which is only the second and most recently detected interstellar visitor to our Solar System, is one of the most pristine ever observed. Astronomers suspect that the comet most likely never passed close to a star, making it an undisturbed relic of the cloud of gas and dust it formed from.

2I/Borisov was discovered by amateur astronomer Gennady Borisov in August 2019 and was confirmed to have come from beyond the Solar System a few weeks later. "2I/Borisov could represent the first truly pristine comet ever observed," says Stefano Bagnulo of the Armagh Observatory and Planetarium, Northern Ireland, UK, who led the new study published today in *Nature Communications*. The team believes that the comet had never passed close to any star before it flew by the Sun in 2019.

Bagnulo and his colleagues used the FORS2 instrument on ESO's VLT, located in northern Chile, to study 2I/Borisov in detail using a technique called polarimetry. Since this technique is regularly used to study comets and other small bodies of our Solar System, this allowed the team to compare the interstellar visitor with our local comets.

The team found that 2I/Borisov has polarimetric properties distinct from those of Solar System comets, with the exception of Hale-Bopp. Comet Hale-Bopp received much public interest in the late 1990s as a result of being easily visible to the naked eye, and also because it was one of the most pristine comets astronomers had ever seen. Prior to its most recent passage, Hale-Bopp is thought to have passed by our Sun only once and had therefore barely been affected by solar wind and radiation. This means it was pristine, having a composition very similar to that of the cloud of gas and dust it -- and the rest of the Solar System -- formed from some 4.5 billion years ago.

By analysing the polarisation together with the colour of the comet to gather clues on its composition, the team concluded that 2I/Borisov is in fact even more pristine than Hale-Bopp. This means it carries untarnished signatures of the cloud of gas and dust it formed from.

"The fact that the two comets are remarkably similar suggests that the environment in which 2I/Borisov originated is not so different in composition from the environment in the early Solar System," says Alberto Cellino, a co-author of the study, from the Astrophysical Observatory of Torino, National Institute for Astrophysics (INAF), Italy.

Olivier Hainaut, an astronomer at ESO in Germany who studies comets and other near-Earth objects but was not involved in this new study, agrees. "The main result -- that 2I/Borisov is not like any other comet except Hale-Bopp -- is very strong," he says, adding that "it is very plausible they formed in very similar conditions."

"The arrival of 2I/Borisov from interstellar space represented the first opportunity to study the composition of a comet from another planetary system and check if the material that comes from this comet is somehow different from our native variety," explains Ludmilla Kolokolova, of the University of Maryland in the US, who was involved in the *Nature Communications* research.

Bagnulo hopes astronomers will have another, even better, opportunity to study a rogue comet in detail before the end of the decade. "ESA is planning to launch Comet Interceptor in 2029, which will have the capability of reaching another visiting interstellar object, if one on a suitable trajectory is discovered," he says, referring to an upcoming mission by the European Space Agency.

An origin story hidden in the dust

Even without a space mission, astronomers can use Earth's many telescopes to gain insight into the different properties of rogue comets like 2I/Borisov. "Imagine how lucky we were that a comet from a system light-years

away simply took a trip to our doorstep by chance," says Bin Yang, an astronomer at ESO in Chile, who also took advantage of 2I/Borisov's passage through our Solar System to study this mysterious comet. Her team's results are published in *Nature Astronomy*.

Yang and her team used data from the Atacama Large Millimeter/submillimeter Array (ALMA), in which ESO is a partner, as well as from ESO's VLT, to study 2I/Borisov's dust grains to gather clues about the comet's birth and conditions in its home system.

They discovered that 2I/Borisov's coma -- an envelope of dust surrounding the main body of the comet -- contains compact pebbles, grains about one millimetre in size or larger. In addition, they found that the relative amounts of carbon monoxide and water in the comet changed drastically as it neared the Sun. The team, which also includes Olivier Hainaut, says this indicates that the comet is made up of materials that formed in different places in its planetary system.

The observations by Yang and her team suggest that matter in 2I/Borisov's planetary home was mixed from near its star to further out, perhaps because of the existence of giant planets, whose strong gravity stirs material in the system. Astronomers believe that a similar process occurred early in the life of our Solar System.

While 2I/Borisov was the first rogue comet to pass by the Sun, it was not the first interstellar visitor. The first interstellar object to have been observed passing by our Solar System was ?Oumuamua, another object studied with ESO's VLT back in 2017. Originally classified as a comet, ?Oumuamua was later reclassified as an asteroid as it lacked a coma.

Notes

[1] Polarimetry is a technique to measure the polarisation of light. Light becomes polarised, for example, when it goes through certain filters, like the lenses of polarised sunglasses or cometary material. By studying the properties of sunlight polarised by a comet's dust, researchers can gain insights into the physics and chemistry of comets.

Source: First interstellar comet may be the most pristine ever found -- ScienceDaily

A “smoking gun” for the ancient calamity that formed Earth’s large Moon may still exist deep in the mantle of our planet.

Evidence for the past impact that created our one large Moon might lie far beneath our feet.

Researchers out of Arizona State University (ASU) made their case in a great piece of planetary forensics presented at the virtual 52nd Lunar and Planetary Science Conference. Their study posits that the large Theia impactor that struck Earth early on in its history, leading to the Moon's formation, might have left large, dense masses deep in our planet's mantle today. The study will appear in *Geophysical Research Letters*.

THE THEIA HYPOTHESIS

The leading theory for the formation of the Moon is that a roughly Mars-size object, dubbed Theia (named for the Titan who was mother to the moon goddess Selene), struck young Earth around 4.5 billion years ago. The abundance of indirect evidence for this cataclysmic event includes the high angular velocity seen in the Earth-Moon system today, as well as the Moon's tiny iron core and high mass ratio relative to Earth. Stable isotope samples brought back by Apollo astronauts also suggest a common origin for Earth and the Moon. But direct evidence for Theia hypothesis has so far been lacking. While the cores of Earth and Theia probably merged right away, where did the rest of the rogue impactor go?

Graduate student Qian Yuan (ASU) and colleagues looked at continent-size features deep in Earth's mantle, known as *large, low shear velocity provinces* (LLSVPs). These two large masses, 1,000 kilometers tall and

several thousand kilometers wide, sit on either side of the Earth's core like a giant set of earmuffs, one under Africa and the other under the Pacific Ocean.

While seismic waves traversing the interior of our planet have revealed these denser regions of the mantle, their origin remains unclear. There are a few different ways in which the LLSVPs might have formed, but the ASU team suspected they could be the remnants of Theia.

Recently, geologists sampled volcanic rocks in Samoa and Iceland, thought to have come from the deep mantle based on chemical studies. Based on those samples, the LLSVPs date back to at least 4.45 billion years ago — right around the time of the suspected Theia impact event.

Yuan and his colleagues simulated the impact and followed the evolution of Theia's remains over time. They found that the its mantle was denser than Earth's, so rather than mixing in, it piled up at the bottom of the mantle against the outer core.

The simulations suggest that Theia might have been much larger than previously suspected, perhaps four times as massive as Mars, and denser too. The Apollo samples support the high density. Lunar rocks exhibit a relatively low ratio of heavy hydrogen (deuterium) to light hydrogen, from which the team calculates that Theia's mantle must have been between 2% and 3.5% denser than Earth in order to retain the light gas. This estimate is consistent with the high density required by their simulations.

LUMPS IN THE GRAVY

The fact remains, though, that we still don't understand the exact nature of the LLSVPs. "We don't know what they (the LLSVPs) are," says seismologist Jennifer Jenkins (Durham University, UK), who was not involved in the study. "They could be piles of subducted oceanic tectonic plates, iron enriched remnants of a basal magma ocean from early in Earth's history when the mantle was still cooling and solidifying, or closely spaced hot thermal upwellings within the convecting mantle that get blurred together into one big 'blob'."

Part of the problem is that the primary method for studying LLSVPs involves examining low-frequency seismic waves, but these paint a fuzzy picture. The masses deep within our planet might be riddled with structure. "There may be holes in them," seismologist Barbara Romanowicz (UC Berkeley) told *Science*. "There may be a bundle of tubes." If so, it could throw the Theia-remnant assertion into doubt.

New techniques, such as utilizing the Moon's tidal pull on Earth, may eventually help narrow down the LLSVPs' structure.

Future lunar sample returns may also help settle the mystery. The Apollo missions sampled equatorial sites on the lunar nearside, but doubts linger over the deuterium-to-hydrogen ratio measured there, mainly due to possible interaction with the solar wind. Scientists would like to resample in the South Pole-Aitken basin, near the lunar south pole. A later impact might have exposed mantle on the basin floor, so it's an ideal site for pristine samples of the lunar interior.

China's Chang'e 4 mission is currently exploring Von Kármán Crater within the basin, and a south pole site will also be the target for NASA's VIPER rover launching in 2023. The crewed Artemis initiative could also pay it a visit in coming years.

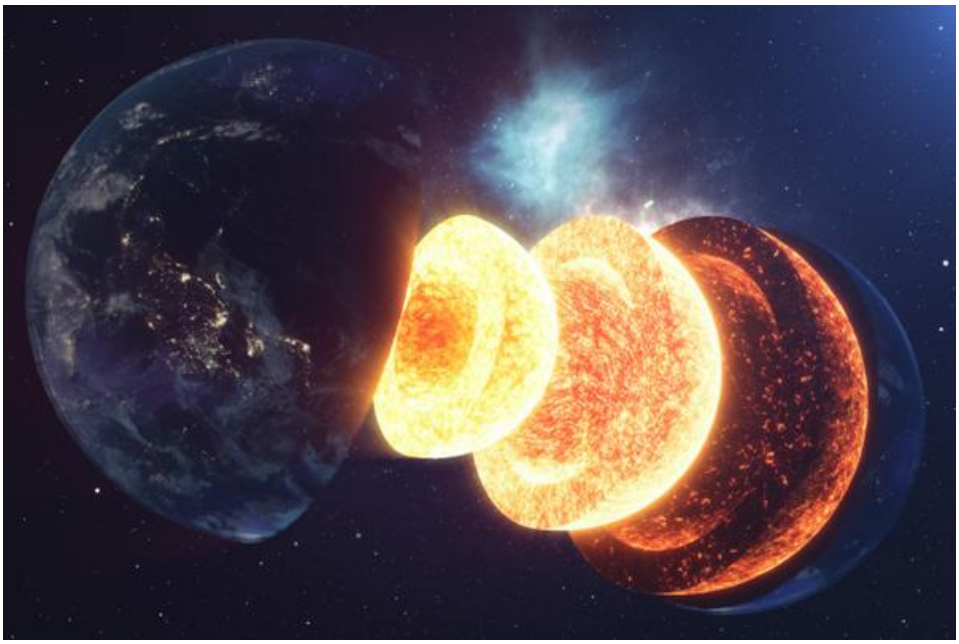
“It would be great to go to the Moon and test whether magmas ‘erupting’ from deep within the Moon record a low deuterium/light hydrogen signature,” says team member Steven Desch (ASU). “The right samples would settle the debate one way or the other.”

Source: Bits of Theia Might Be in Earth's Mantle - Sky & Telescope - Sky & Telescope (skyandtelescope.org)

Earth has been hiding a fifth layer in its inner core

Scientists say they've detected a new, mysterious layer at the center of our home planet. The discovery could unearth more about Earth's history.

By Donna Sarkar | Published: Friday, March 26, 2021

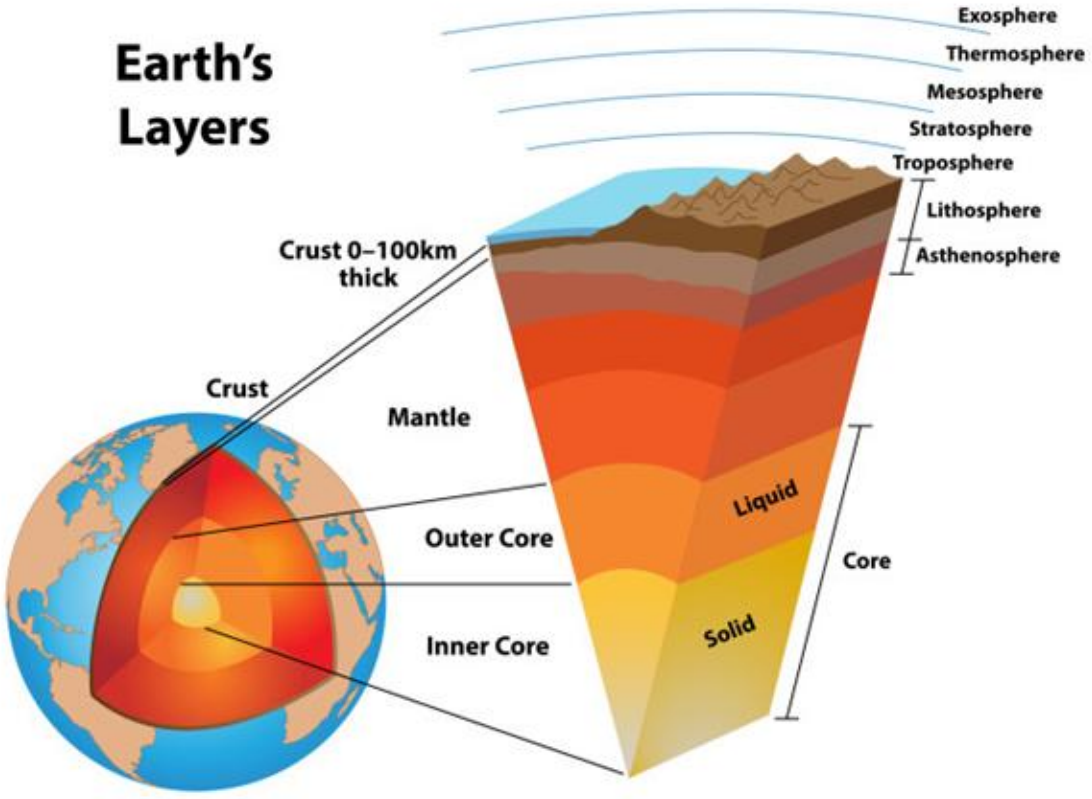


One of geology's basic principles is that the Earth is made up of four layers: the crust, the mantle, the outer core, and the inner core. But this may be squashed in light of a new study that suggests Earth actually has a distinct fifth layer that's been under our feet all along.

Researchers at the Australian National University (ANU) say that the new layer they uncovered is located within Earth's inner core. Deeper analysis of this discovery could help scientists better understand our planet's history and evolution.

A peek inside Earth

Approximately 4.6 billion years ago, the Earth formed. The story starts with the planet's interior or rocky core, which formed through the collision of heavy elements. The core, found at the center of the Earth, is made up of two parts. The outer layer, comprised of liquid iron alloy, is about 1,355 miles thick. The outer core is also thought to be responsible for Earth’s magnetic field. In contrast, the inner core is made up of solid iron alloy with a radius of 760 miles. Next comes the mantle, which sits directly above the core. This layer is composed of mostly silicate rocks that are rich in magnesium and iron. The mantle has a thickness of about 1,793 miles, making it Earth's thickest layer. The thinnest and most brittle layer is the crust, however. It varies between 18.6 to 43.5 miles in thickness and forms the outermost layer of our home planet.



Earth's layers before the discovery of the innermost-inner core. The newest layer is situated just below the inner core.

OSweetNature/Shutterstock

The fifth layer

Scientists have long suspected that Earth's inner core was made of two layers. But it wasn't until ANU researchers took a closer look at what lies below that an “innermost inner core" was confirmed.

Their work revealed a distinct change in the structure of iron deep within the inner core at about 3,604 miles below the Earth's surface. You may recall from earlier that the inner core consists of solid iron alloy. This is due to high pressure deep within the Earth that stops the iron alloy from melting. But distinct structural changes were detected in this iron alloy that set apart the newly discovered innermost layer from the rest of the inner core.

According to Salon, this discovery led the researchers to believe that the change in structure may have been caused by an unknown, dramatic event early in Earth’s history. Further examination of this tiny layer may provide additional details around how our planets formed.

“The details of this big event are still a bit of a mystery, but we've added another piece of the puzzle when it comes to our knowledge of the Earths' inner core,” said the study’s lead author and researcher, Joanne Stephenson, in a statement.

Behind the scenes of the discovery

Seismic monitoring allows us to gain a better understanding of Earth's interior. This is made possible by measuring sound waves that are created by earthquakes and pass through Earth's layers. By analyzing how the different layers cause the sound waves to slow down, scientists can catch a glimpse of what lies below.

The recent discovery was made with the aid of a special search algorithm that researchers used to compare

thousands of models of the inner core with decades worth of data on how long seismic waves take to travel through Earth. This data, gathered by seismograph stations all over the world, helped detect the changes in the structure of iron in the inner core. These findings helped confirm that Earth's inner core has another layer.

Although this work is still being analyzed, the discovery of a new layer may pave the way for a new geological principle and prompt textbooks to be rewritten. Source: Earth has been hiding a fifth layer in its inner core | Astronomy.com

ASTRONOMY COLUMN

APRIL EVENTS:

1. The next club meeting April 5th. We are set up for a zoom meeting. Info in the China Lake Astronomical Society news letter.

2. Star parties for the future have been cancelled until further notice.

APRIL CELESTIAL CALENDAR:

1. Jupiter and Saturn in the morning sky this month. Look for them in the southeast before sunrise.

2. Mars can be seen high in the west soon after sunset.

3. Venus moves to the evening sky this month but is only easily visible the last week. Look for it low in the west after sunset.

4. Mercury also moves to the evening sky after its April 18th conjunction with the sun. Also look for it in the west after sunset the last week of the month.

5. The Lyrid meteor shower peaks on April 22nd but will be mostly wiped out by the waxing gibbous moon.

INFORMATION:

Please visit us at our new website ChinaLakeAstro.org.

For more information, contact the China Lake Astronomical Society at 760-446-0454 or 760-384-8666.

Roger Brower

Basic CLAS dues are $25.00 per year - due in January. Students and Skywatchers Newsletter are FREE.

Members also receive discounted rates for Astronomy Magazine and /or Sky and Telescope Magazine.

The fee schedule is as follows: Verify current magazine prices with Roger!

Basic membership $25.00 per year.
Membership with Astronomy magazine is $59.00 per year.
Membership with Sky and Telescope magazine is $58.00 per year.
Membership with both S & T and Astronomy is $92.00 per year.

Send your Check or Money Order to:

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Meetings of the China Lake Astronomical Society are held at the Maturango Museum at 7:30 p.m. on the first Monday evening of each month, except when the first Monday is a holiday.

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